

Shell Lake Fishery Survey, Washburn County, Wisconsin 2018

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Executive Summary

A comprehensive survey of Shell Lake, Washburn County, was conducted during the 2018 sampling season. The primary objective of this survey was to evaluate gamefish and panfish populations. The secondary objective was to evaluate the regulation changes for walleye and largemouth and smallmouth bass.

Gamefish collected included walleye, northern pike, muskellunge, and smallmouth and largemouth bass. The 2018 adult walleye population estimate on Shell Lake was 1,524 fish, similar to the 2013 estimate. Catch rates for northern pike were 1.9 fish/net night, similar to 2012 (2.1 fish/net night), still lower than 2002 (7.4 fish/net night). Thirty-two adult muskellunge collected ranging from 30.3 to 50.0 in. A total of 260 smallmouth bass were collected ranging from 6.5 to 19.0 in. Mean length of smallmouth bass was 13.3 in, an increase from 2013 (12.7 in) and 1999 (12.8 in). The largemouth bass catch rate decreased from 15.9 fish/mile (2013) to 3.1 fish/mile. There were no large changes with panfish except for yellow perch, which catch rate increased from 0 to 44.0 fish/mile.

Management recommendations include: 1) The walleye regulation should stay in place at no minimum, one fish over 14 in; three bag limit. 2) Fall walleye recruitment surveys should occur annually, if possible. 3) Northern pike densities are similar to the last survey; no regulation change is needed. 4) Muskellunge are at very low densities; stocking adjustments should be considered. 5) The no-minimum size limit for largemouth and smallmouth bass should remain in place. 6) Bluegill should continue to be monitored as bass densities decrease. 7) Walleye spawning habitat should be protected. 8) Efforts to increase habitat complexity should be considered. 9) Invasive species monitoring and prevention should continue.

Introduction

Shell Lake is a soft-water seepage lake in Washburn County. The lake's shoreline is primarily privately owned and highly developed (Stoughtenger et al. 2013). Shell Lake is 2,513 acres with a maximum depth of 36 feet and mean depth of 23 ft. Shell lake is classified as a complex warm-clear waterbody, complex meaning it has more than four species of gamefish and warm-clear referring to the water quality based on seasonal temperatures and water clarity (Rypel et al. 2019). Shell lake's classification is transitional between a cool and warm lake (data from Rypel et al. 2019).

Shell Lake is a clear-water, mesotrophic lake. Trophic State Index (TSI) is an index for evaluating trophic state or nutrient condition of lakes (Carlson 1977; Lillie et al. 1993). TSI values can be computed using water clarity (secchi disk measurements), chlorophyll-a, and total phosphorus values. TSI values represent a continuum ranging from very clear, nutrient poor water (low TSIs) to extremely productive, nutrient rich water (high TSIs). The data on Shell Lake in 2018 (WDNR 2018) indicate the most recent nutrient conditions were oligotrophic (low productivity) when considering secchi disk, total phosphorus, and chlorophyll-a TSI indices. Shell lakes TSIs have ranged oligotrophic to eutrophic, depending on the year (WDNR 2018).

Gamefish species present in Shell Lake include largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, walleye *Sander vitreus*, muskellunge *Esox masquinongy*, and northern pike *E. lucius*. Panfish species include bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, pumpkinseed *L. gibbosus*, yellow perch *Perca flavescens*, and rock bass *Ambloplites rupestris*. Other fish species common in Shell Lake include bowfin *Amia calva*, and white sucker *Catostomus commersoni*. Invasive species present in Shell Lake include curly-leaf pondweed *Potamogeton crispus*, banded mystery snail *Viviparus georgianus*, and Chinese mystery snail *Bellamya chinensis*.

Recent fisheries management activities on Shell Lake have focused on surveys and fish stocking. Since 1997, muskellunge have been the only fish species stocked into Shell Lake (Appendix Table 1). During this survey, all of the standard statewide fishing regulations applied to Shell Lake, except for special regulations for walleye and black bass species. The walleye regulation was recently changed from no minimum length limit; sliding bag limit to no minimum length limit, one fish ≥ 14 in and a three-bag limit in 2016. Also, largemouth and smallmouth bass went from a 14 in minimum size limit to no minimum size limit, five-bag limit in 2016.

Numerous fisheries surveys, primarily targeting walleyes, have been conducted by Wisconsin Department of Natural Resources (DNR) and Great Lakes Indian Fish and Wildlife Commission (GLIFWC) in recent years. Since 1992, 19 fall surveys assessing juvenile walleye recruitment have been conducted on Shell Lake by either GLIFWC or Wisconsin DNR staff. The only years Shell Lake was not assessed for juvenile walleye recruitment were 1997, 2000, and 2007. The last comprehensive survey of Shell Lake was conducted in 2013.

The primary objective of this study was to assess the status of the gamefish and panfish populations in Shell Lake. Secondary objectives were to assess any effects from the recent regulation changes in 2016.

Methods

Field Sampling

Shell Lake was surveyed during 2018 following the Wisconsin DNR lake assessment protocol (Simonson et al. 2008). Spring sampling utilized fyke nets and electrofishing to assess gamefish and panfish populations. Fall electrofishing targeted young-of-year (YOY) walleye.

Fyke nets were set soon after ice out on 05 May. Nets were checked daily and set at areas expected to contain high concentrations of spawning walleye, muskellunge, and northern pike.

Nets were removed on 12 May, with a total effort of 90 net nights. After removal of nets, the entire shoreline of Shell Lake was sampled with an electrofishing boat on 12 May for the adult walleye recapture run.

All walleyes, muskellunge, and northern pike captured during the spring portion of the survey were measured to the nearest 0.5 in and given sex was determined for walleyes, muskellunge, and northern pike by the presence of gametes. All adult walleye, northern pike, and muskellunge were given a left ventral fin clip, juveniles were given a top caudal fin clip. In addition to length data, all muskellunge were given a passive integrated transponder (PIT) tag in the left cheek.

Three two-mile gamefish stations were night-time electrofished on 5 June targeting smallmouth and largemouth bass. In addition, three half-mile stations were embedded in each two-mile station targeting all panfish. An additional 2.3 miles were electrofished for smallmouth and largemouth bass (8.3 miles – gamefish, 1.5 miles – panfish). Five fyke-nets were set on 19 June targeting panfish. These nets were set overnight for a total effort of five net nights.

The final component of the lake sampling consisted of a fall electrofishing run on 1 October. During this survey, only walleye <12.0 in were targeted and collected over the entire shoreline.

Age and Statistical Analysis

For age analysis, scale samples were removed from walleyes (≤ 15 in) and smallmouth/largemouth bass (≤ 12 in), while dorsal spines were removed from larger walleyes, smallmouth bass, and largemouth bass. Muskellunge anal spines were taken to assess strength of stocked year classes. Age interpretations on northern pike were not conducted due to the

unreliability and difficulty of determining annuli. Casselman (1990) found this to be due to irregular growth and resorption or erosion on the midlateral region. The descending limb of a catch curve regression was used to estimate smallmouth bass total annual mortality (Ricker 1975).

Size structure quality of species sampled was determined using proportional stock density (PSD) indices (Neumann et al. 2013) when there was a sample size greater than 100. The PSD value for a species is the number of fish of a specified length and longer divided by the number of fish of stock length or longer, the result multiplied by 100. Catch per Unit Effort (CPE) was calculated as the number of fish captured divided by the appropriate unit of sampling effort for that species (e.g. – fish/net night or fish/mile of shoreline).

Results

Early Spring Fyke-Netting and Electrofishing

Walleye. The 2018 adult walleye population estimate on Shell Lake was 1,524 fish (CV = 0.32), similar to the 2013 estimate (Figure 1). The estimated density (0.6 fish/acre) was below densities of other Ceded Territory walleye lakes where natural reproduction was the primary source of recruitment (0.9 – 6.5 fish/acre – Cichosz 2018). The CPE was 2.8 fish/net night and 7.4 fish/mile, both lower than 2013.

Adult walleye captured in 2018 ranged from 13.5 to 23.5 in (Figure 2). Mean lengths of male and female walleye were 15.9 in (standard deviation (SD) = 1.1) and 17.5 in (SD = 1.4), respectively. The male to female ratio was 1:1. Walleye were generally smaller in 2018 than 2013 (Figure 3). The proportional stock density (PSD) and PSD-20 for walleye captured in fyke-

nets was 85 and 3, respectively. PSD decreased from 2013 (100), while PSD-20 stayed the same (3).

Growth rates for both sexes of walleye are below regional averages. This trend is well documented in recent surveys (Figure 4 and 5). Catch curve analysis and von Bertalanffy growth curves were not used due to high abundance one-year class.

Northern pike. A total of 175 northern pike, ranging from 9.5 to 39.2 in were captured in spring 2018 (Figure 6). The male to female ratio was 2:1. Mean lengths of female and male northern pike captured in 2018 were 23.0 in (S.D. = 5.2) and 20.4 in (S.D. = 2.3), respectively. PSD and average length were comparable to previous surveys (Table 1). Catch rates for northern pike were 1.9 fish/net night, similar to 2012 (2.1 fish/net night), still lower than 2002 (7.4 fish/net night).

Muskellunge. A total of 34 muskellunge were collected in fyke-nets in 2018. Thirty-two fish were considered adults ranging from 30.3 to 50.0 in. The male to female ratio was 1:1. Muskellunge were larger when compared to 2002-03 and 2012-13 (Figure 7). Two muskellunge were collected that were less than 30 in. Adult muskellunge averaged 41.3 in and were larger compared to 2012-13, where they averaged 38.9 in. Fifty-nine percent of the adults were greater than 40 in, compared to 26% in 2013. Muskellunge catch rates were also higher than 2012-13 (0.2 fish/net night) at 0.4 fish/net night.

Muskellunge mean length-at-age was better than the Northern Wisconsin average and comparable to Rice Lake, Barron County, WI (Figure 8). Ninety-seven percent of the fish collected were from year classes that corresponded with fish stocking.

Late-Spring Electrofishing and Fyke-netting

Smallmouth bass. A total of 260 smallmouth bass were collected on 5 June ranging from 6.5 to 19.0 in. Mean length of smallmouth bass was 13.3 in (S.D. = 2.8), an increase from 2013 (12.7 in) and 1999 (12.8 in) (Figure 9). The catch rate decreased to 31.3 fish/mile, compared to 2013 (40.0 fish/mile) and 1999 (36.7 fish/mile). PSD and PSD-14 were 74 and 56, both increased from 2013 (PSD = 71; PSD-14 = 55). Fifty-five percent of the smallmouth bass collected were over 14 in. Age-3 smallmouth bass were most abundant, and growth remained similar to 2013 (Figure 10). Smallmouth bass survival was slightly lower at 67% compared with 72% in 2013 (Figure 11).

Largemouth bass. A total of 26 largemouth bass were collected on 5 June ranging from 6.4 to 17.1 in. Mean length was 13.9 in (S.D. = 2.6), a large increase from 2013 (11.0 in). Catch rate decreased from 15.9 fish/mile (2013) to 3.1 fish/mile. PSD was not calculated due to the small sample size. Average length-at-age was similar to 2013 for the few age classes collected (Figure 12).

Panfish. A total of 128 bluegill were collected on 5 June ranging from 2.1 to 9.3 in. Mean length was 4.7 in (S.D.=2.0), similar to 2013 (4.8 in avg.). The catch rate was 85.3 fish/mile, a slight decrease from 2013 (89.3 fish/mile). PSD and PSD-8 was 24 and 14, respectively. These values increased when compared to 2013 electrofishing data (PSD=15; PSD-8=1). Bluegill average length-at-age was above the northern region average for most ages (Figure 13).

Other panfish collected consisted of yellow perch, rock bass, pumpkinseeds, and black crappie. The second most abundant panfish was yellow perch at 44 fish/mile, a large increase from electrofishing in 2013 (0 collected). Yellow perch ranged in length from 2.5 to 5.4 in (mean length = 3.6 in; S.D. = 0.5). Rock bass were captured at a rate of 18.7 fish/mile (mean

length = 7.0 in; S.D. = 1.7), a decrease from 2013 (catch rate = 46.7 fish/mile; mean length = 7.9 in). Pumpkinseeds were captured at a rate of 6.0 fish/mile (mean length = 6.7 in; S.D. = 1.2), similar to 2013 (2.7 fish/mile). Black crappie were captured at low densities in both 2013 (7.3 fish/mile) and 2018 (4.7 fish/mile). Panfish fyke-net data was not used in the 2018 analysis, due to low sample size (one night) compared with 2013 and 1999.

Fall Electrofishing

Catch rates of YOY walleye were well above average for lakes with natural reproduction (19.3 fish/mile – Cichosz 2018) in 2018 at 78.2 fish/mile. The average catch rate of YOY walleye in surveys conducted by both Great Lakes Indian Fish and Wildlife Commission and Wisconsin DNR crews between 1990 and 2018 was 32.4 fish/mile (S.D. = 33.4, N = 23; (Figure 14)). Age-1 walleye were also abundant at 6.6 fish/mile of shoreline above the long-term average of 4.5 fish/mile (S.D. = 5.4, N = 22; (Figure 15)).

Discussion

The 2018 fishery survey shows that Shell Lake remains a fishery for walleye, smallmouth bass, and muskellunge. The lake also offers opportunities for panfish and largemouth bass. However, there are some significant shifts occurring in densities of walleye and muskellunge over the past 20 years.

Shell Lake walleye continue to have erratic natural recruitment. However, the four highest young walleye catches since 1990 have occurred within the past seven years. (2011, 2013, 2017, 2018 – Figure 14). It is difficult to determine what is driving recent success of walleye natural reproduction in Shell Lake. A few factors may be driving these changes: 1) the

2016 regulation change, 2) increasing yellow perch abundance, or 3) increased walleye harvest. First, increased natural reproduction may be a result of the walleye population reacting to the new regulation. The current regulation (one fish ≥ 14 in) focuses harvest on immature walleye and males but protects mature females. An increase in numbers of mature female walleye increases the chances of a successful spawning event. This scenario seems unlikely since the regulation has only been in place for three fishing seasons. Second, there has been a notable increase in yellow perch in Shell Lake since 2013. This species is known to be a preferred prey item for walleye (Chipps and Graeb 2011). The recent increase in yellow perch abundance may have increased survival of walleye compared with years where perch densities were low in Shell Lake. Last, the walleye population may be reacting to increased overall harvest on the walleye fishery. The increased recruitment may be a compensatory response of the population becoming very low (Rose et. al 2001). The remaining adults can give more energy to reproduction and have the capacity to replenish the walleye population of the lake. This scenario may result in low abundances followed by very high abundances. This scenario also creates a very unstable walleye population. This scenario is possible given the wildly variable recruitment we have seen in recent years. Ideally, the current regulation will help mitigate this scenario and create a trend of more stable yearly natural walleye recruitment.

Based on our fish aging data, the most abundant walleye year class present was from 2011. It also appears that the abundant 2013-year class didn't survive well, was heavily harvested, or simply was not present in our survey. It is likely that the new regulation (1 fish ≥ 14 in) came into effect when this year class was mostly 12.0 – 14.0 in (three years old – see Figure 5). This potential harvest may have dramatically reduced the 2013 year class before they were mature. The 2018 population estimate was lower than other Ceded Territory walleye lakes

where natural reproduction was the primary source of recruitment (0.9 – 6.5 fish/acre – Cichosz 2018). However, the large juvenile catch rates in 2017 and 2018 suggest Shell Lake will once again rebound with better adult walleye numbers.

Northern pike catch rates are at moderate levels but still lower than 2002 levels. However, size structure improved when compared to the 2012 survey. As discussed in Roberts and Wendel (2015), the lowered abundance is likely correlated with habitat and lower abundances of aquatic vegetation in Shell Lake. If opportunities exist to improve aquatic vegetation habitat in Shell Lake, that should be explored to benefit both northern pike and muskellunge.

Muskellunge are currently meeting the catch rate objectives for a Class A1 fishery (0.25 – 0.73 fish/net-night WDNR Fisheries Management Handbook-internal publication). Muskellunge relative abundance did improve when compared with past two muskellunge surveys. However, the sample size (n=34) was small and our sampling period was short. This may have inflated catch rates. Shell Lake does still offer trophy potential for muskellunge with fish up to 50 inches collected. Aging showed that Shell Lake muskellunge are completely reliant on stocking. There was only one fish was from a non-stocked year class. Muskie remain the rarest gamefish in Shell Lake but provide anglers another fishing opportunity.

Smallmouth bass abundance decreased when compared with 2013 catch rates. However, the decrease was not substantial and remained close to the relative abundance observed in 1999. A modest increase in average size and percent of smallmouth bass over 14 inches was also observed in this survey. This data suggests smallmouth bass harvest may have helped improve size structure. Anglers have been documented to harvest more smallmouth bass from Shell Lake, when walleye abundances are lower (Roberts and Wendel 2015). The new 2016 bass

regulation (no minimum size limit, five fish daily bag limit) may have also triggered these changes and allowed anglers to harvest more smallmouth bass.

Largemouth bass abundance decreased dramatically when compared with the 2013 survey. The electrofishing catch rate dropped by 81%. This shift is likely related to increased harvest of largemouth bass by anglers. Removing the minimum length limit created new harvest opportunities and it appears anglers took advantage of that on Shell Lake.

Bluegill catch rates and average size were very similar to 2013. They continue to have above average growth for the north district. This fishery appears stable when compared to the last survey in 2013. Yellow perch were the second most abundant panfish collected. Though non-existent in the 2013 electrofishing survey, yellow perch were highly prevalent in the 2013 mini-fyke net data. This data likely reflects the increased perch numbers we observed in this survey. The increase is a positive trend for the overall fish community. Walleye, muskellunge, and northern pike all prey on yellow perch when available (Bozek et al. 1999; Bozek et al. 2011; Margenau et al. 1998). Rock bass, black crappie, and pumpkinseeds offer additional opportunities for panfish in Shell Lake.

Management Recommendations

1. Walleye remain the primary gamefish of interest in Shell Lake. Their population continues to be unstable, though large natural recruitment events continue to sustain the population. The one fish over 14 in; three bag limit should stay in effect. The goal of this regulation is to protect female walleye.
2. Fall walleye recruitment surveys should occur annually, if possible. Tracking the natural recruitment trends is important for future walleye management in Shell Lake.

3. Northern pike densities remain similar to 2013. Based on these results, the current regulation should stay in effect. Lack of aquatic vegetation in Shell Lake is likely limiting the overall abundance of northern pike.
4. Muskellunge remain at very low densities. If opportunities exist to adjust muskellunge stocking rates or size at stocking, these options should be explored.
5. The current no-minimum size limit on largemouth bass and smallmouth bass should remain in place. Largemouth bass densities decreased from their peak in 2013. Smallmouth densities also decreased, but not severely. The goal is to keep largemouth bass densities low in Shell Lake, while maintaining a good smallmouth bass fishery. Smallmouth bass densities can be reduced, but if it is apparent this reduction is not leading to better growth, a new regulation should be considered.
6. Bluegill should continue to be monitored as bass densities decrease. Potential impacts should continue to be evaluated during the next survey.
7. Walleye spawning habitat in Shell Lake should be protected. Efforts should be made to work with the City of Shell Lake to develop a plan to achieve this goal.
8. Efforts to increase habitat complexity in Shell Lake should be encouraged. Inputs of coarse woody debris, protection/promotion of aquatic vegetation, and maintenance/restoration of vegetative buffers are needed habitat work on Shell Lake.
9. Invasive species monitoring and control programs should continue. Efforts to keep aquatic invasive species out of a waterbody are much more effective than controlling invasive species once they are established.

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Table 1. Northern pike PSD and PSD-28 values from fish collected during spring spawning population assessments on Shell Lake, Washburn County.

Parameter	2018	2012	2003	1999	1977
PSD	52	29	28	32	12
PSD-P	6	4	1	3	2

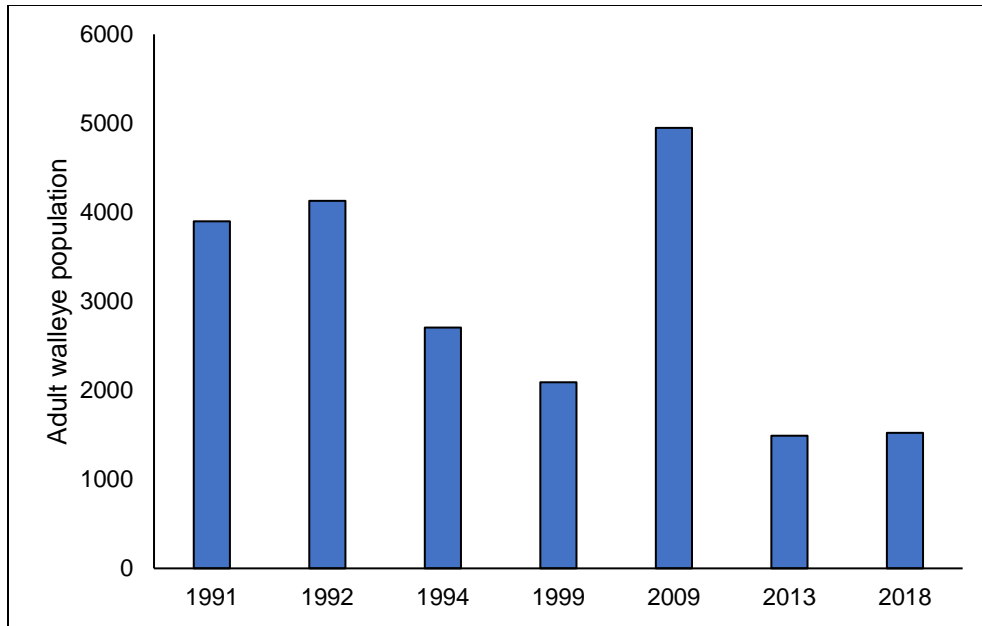


Figure 1. Adult walleye population estimates for Shell Lake, Washburn County, Wisconsin.

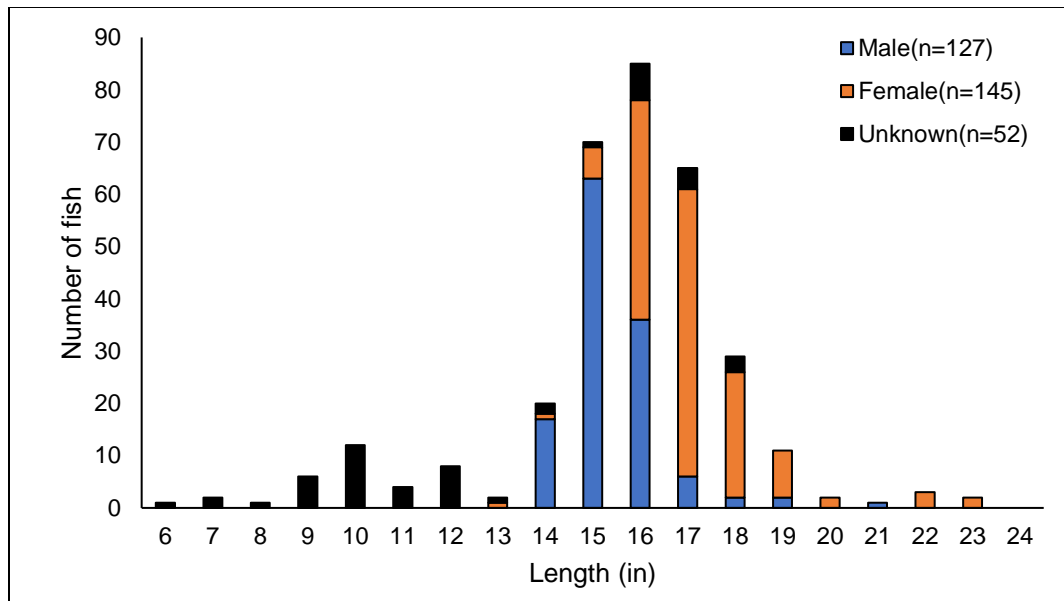


Figure 2. Length frequencies of all walleye captured during spring 2018 sampling in Shell Lake, Washburn County, Wisconsin (n=324).

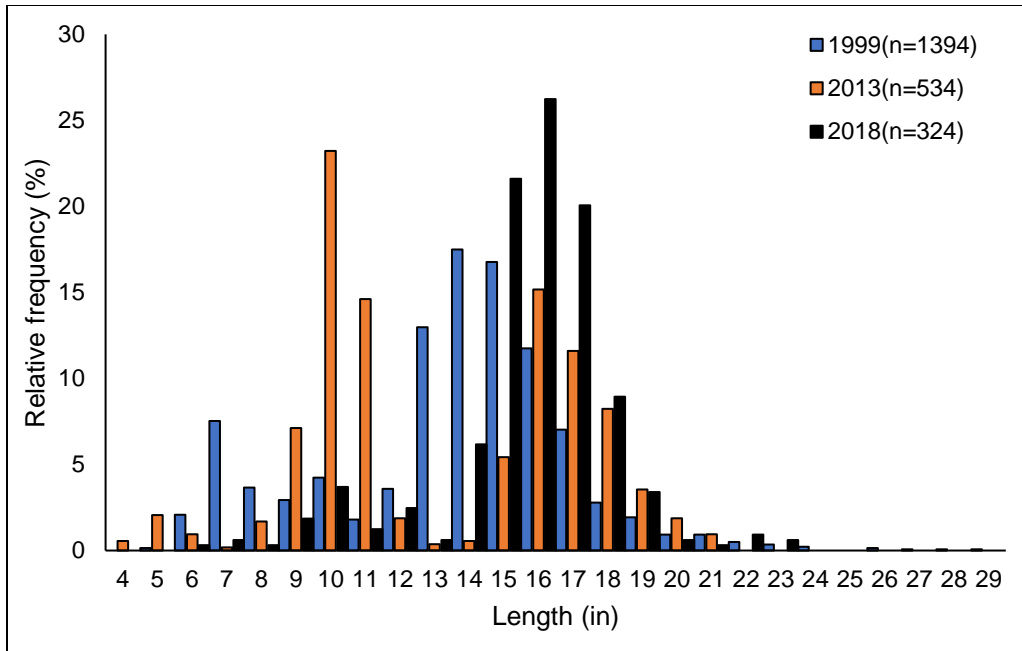


Figure 3. Relative frequency (%) of walleye captured in spring 1999, 2013, and 2018 in Shell Lake, Washburn County, Wisconsin.

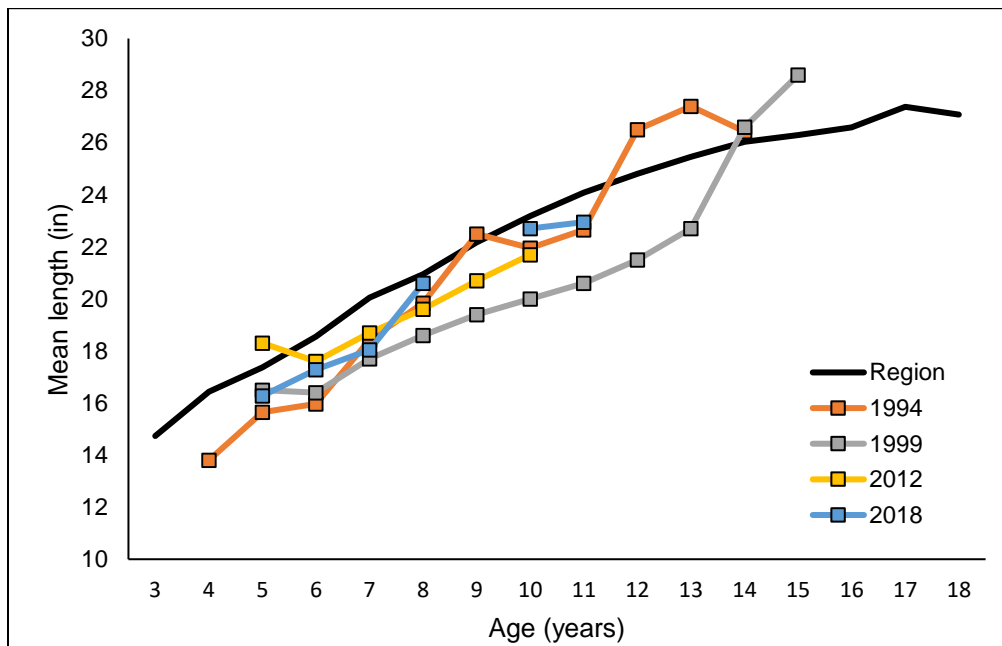


Figure 4. Mean lengths at age for female walleyes captured during spring surveys on Shell Lake, Washburn County, Wisconsin. Regional averages are displayed for comparison.

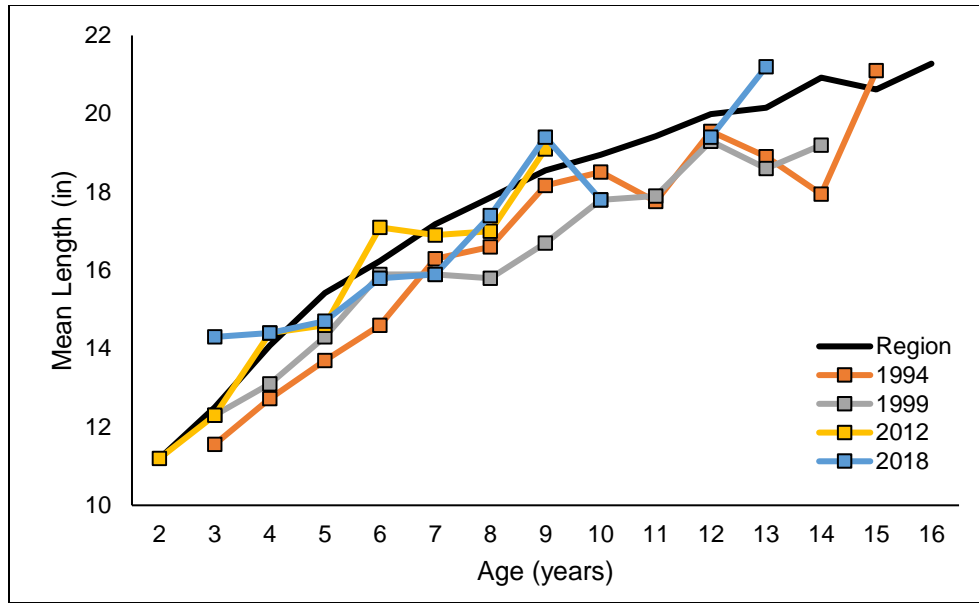


Figure 5. Mean lengths at age for male walleyes captured during spring surveys on Shell Lake, Washburn County, Wisconsin. Regional averages are displayed for comparison.

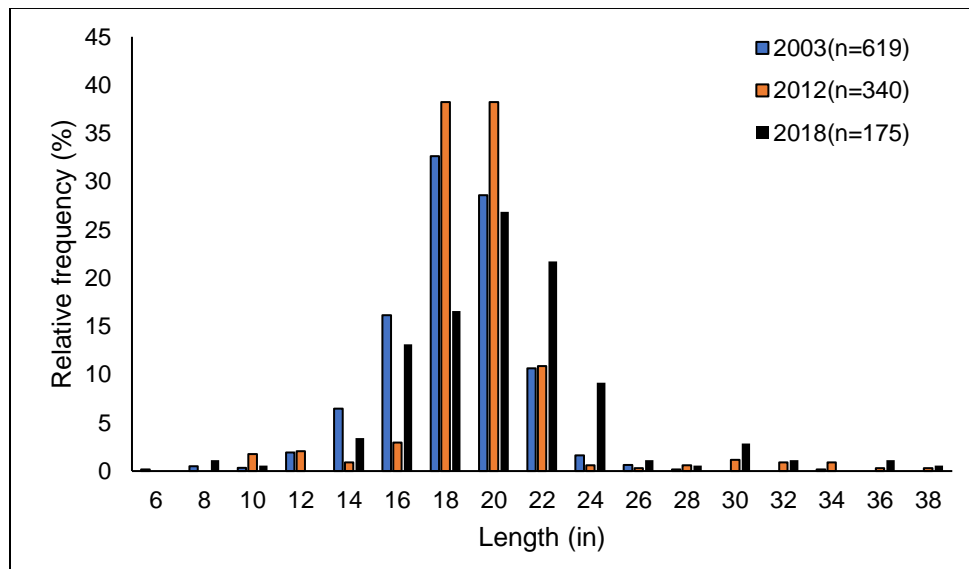


Figure 6. Relative length frequency of northern pike captured in Shell Lake, Washburn County, Wisconsin.

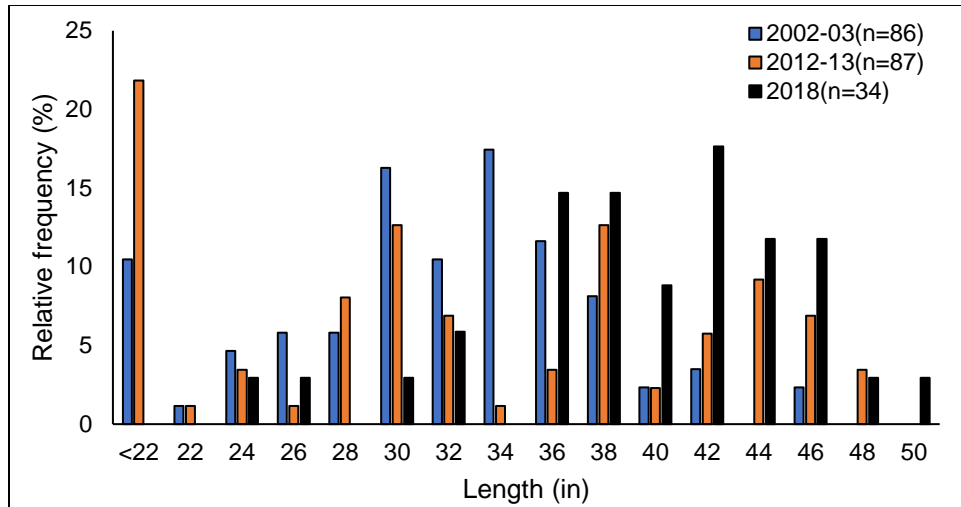


Figure 7. Relative length frequency of muskellunge captured in Shell Lake, Washburn County, Wisconsin.

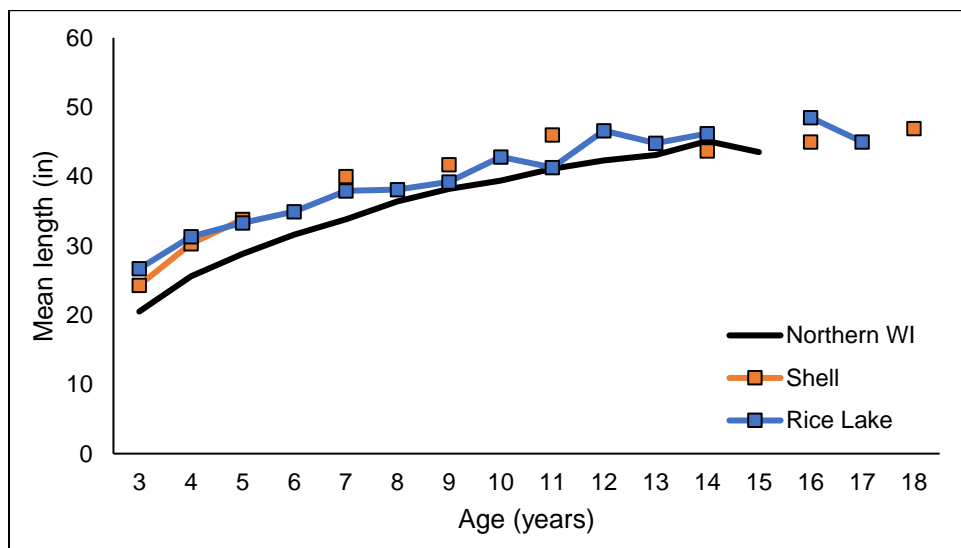


Figure 8. Mean length-at-age for muskellunge collected in Shell Lake, Washburn County, Wisconsin.

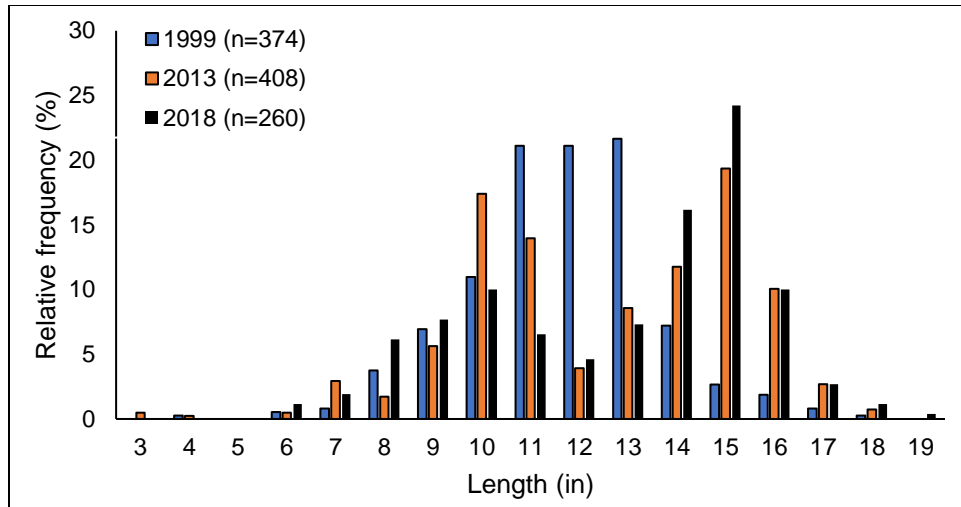


Figure 9. Relative length frequency of smallmouth bass captured in Shell Lake, Washburn County, Wisconsin.

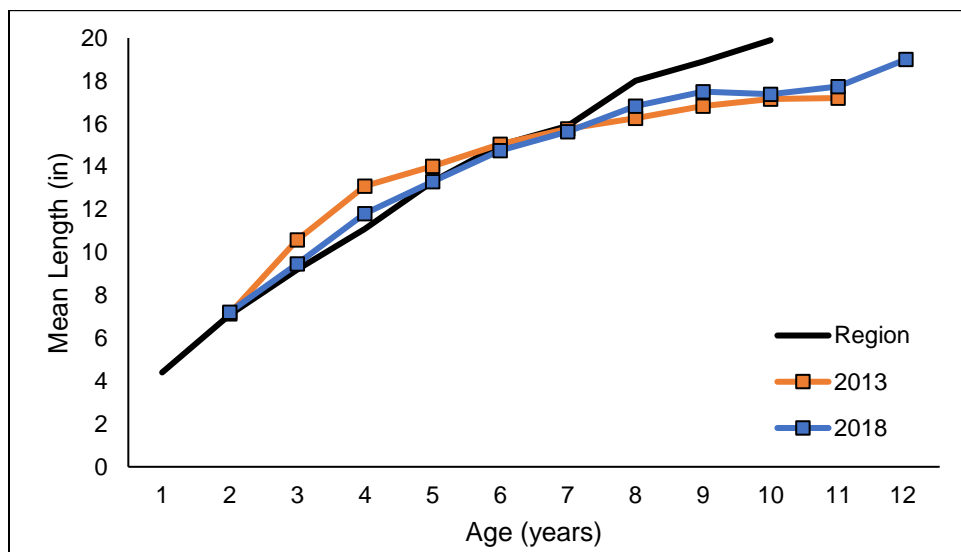


Figure 10. Mean length-at-age for smallmouth bass collected in Shell Lake, Washburn County, Wisconsin.

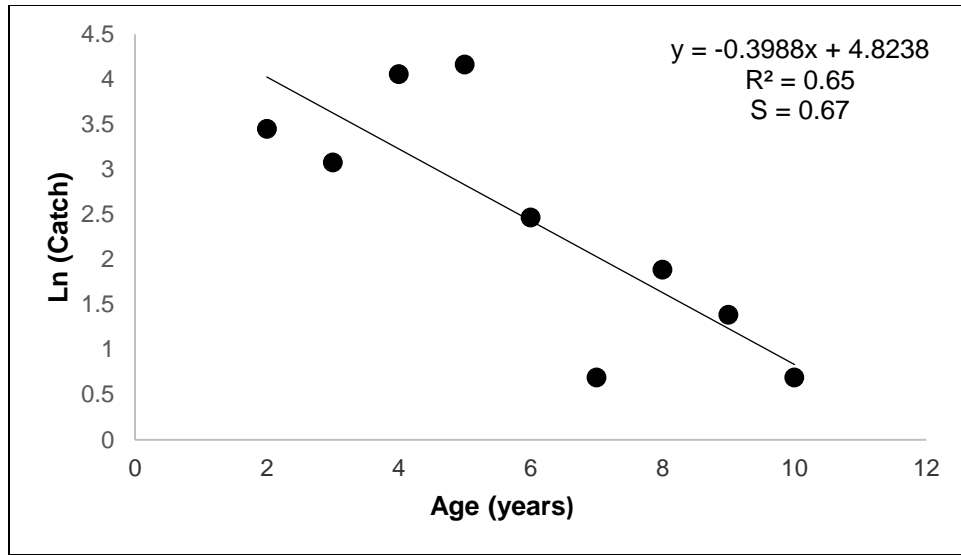


Figure 11. Survival rate of smallmouth bass for Shell Lake, Washburn County in 2018.

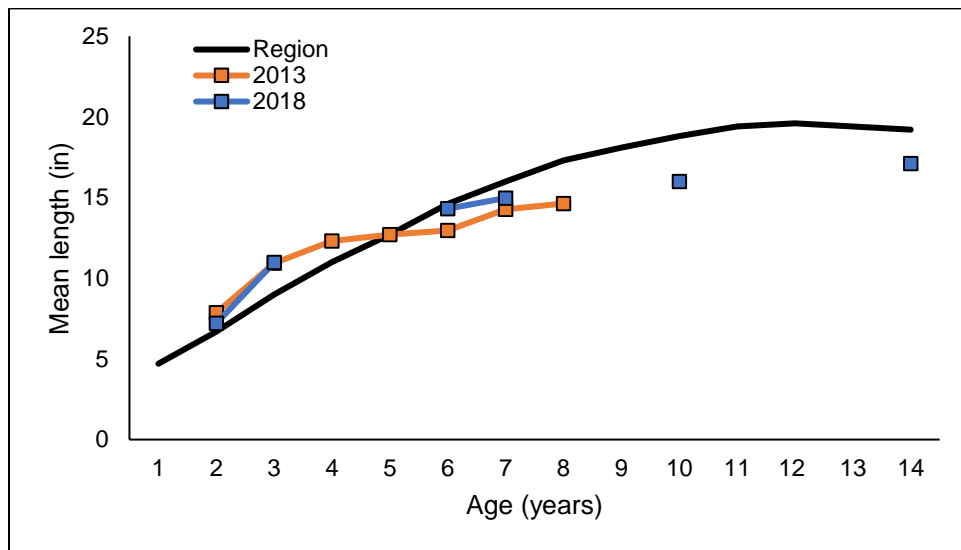


Figure 12. Mean length-at-age for largemouth bass collected in Shell Lake, Washburn County, Wisconsin.

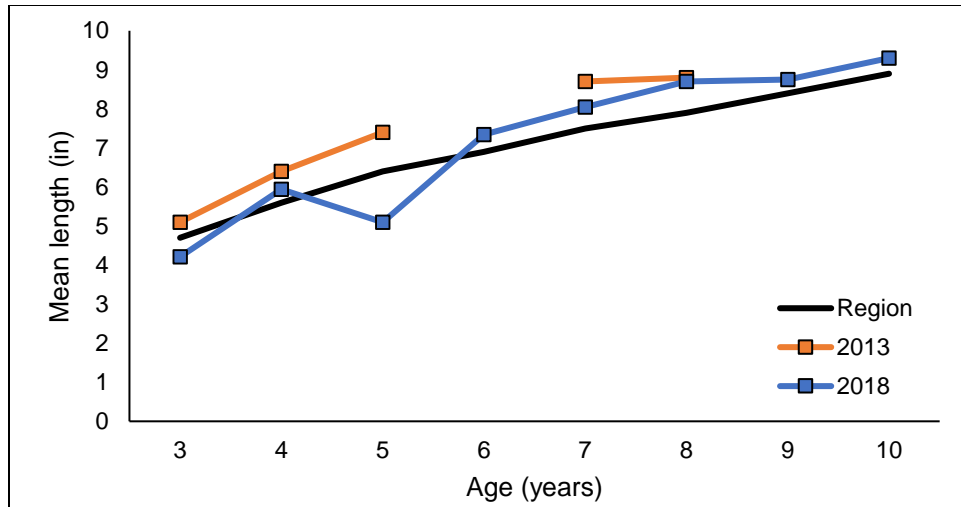


Figure 13. Mean length-at-age for bluegill collected in Shell Lake, Washburn County, Wisconsin.

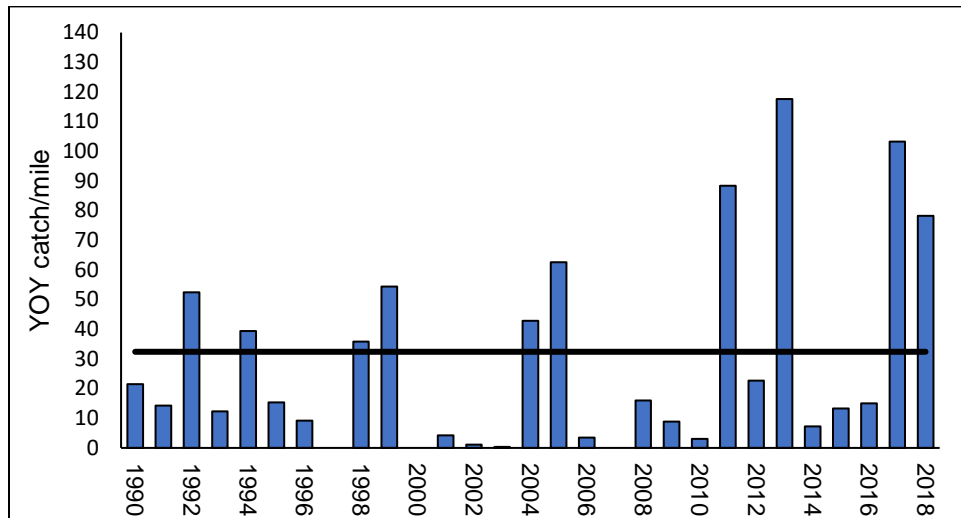


Figure 14. Young of year (YOY) walleye relative abundance determined by fall electrofishing surveys on Shell Lake, Washburn County. The black horizontal line represents the YOY average catch/mile of 34.2. Fall surveys were not conducted on Shell Lake in 1997, 2000, and 2007.

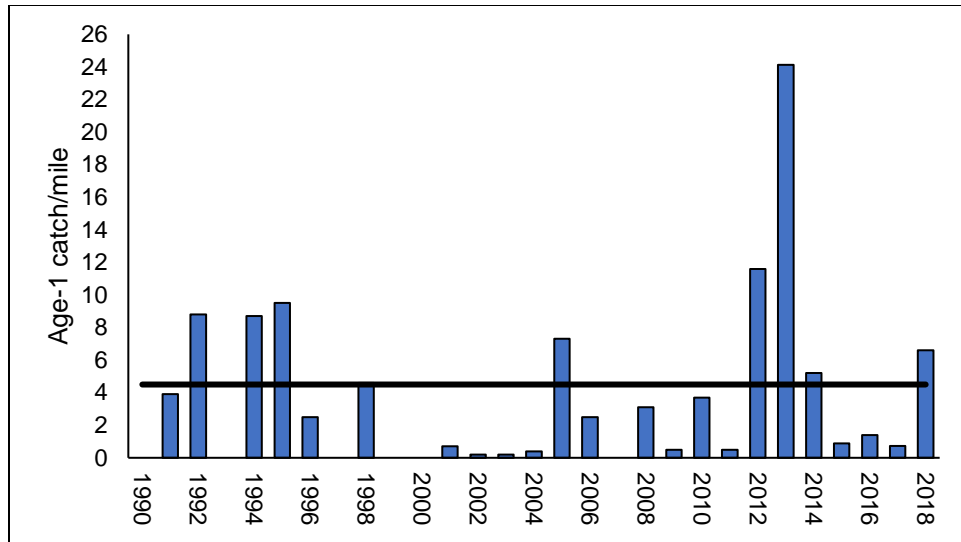


Figure 15. Age-1 walleye relative abundance determined by fall electrofishing surveys on Shell Lake, Washburn County. The black horizontal line represents the age-1 average catch/mile of 4.5. Data was not collected on age-1 walleye in 1993, 1997, 1999, 2000, and 2007.

Appendix Table 1. Fish stocking records for Shell Lake, Washburn County, Wisconsin, 1998-2018.

Year	Species	Number Fish Stocked	Mean Fish Length (in)
1998	Muskellunge	2,500	12.0
2000	Muskellunge	1,776	12.1
2002	Muskellunge	1,284	10.7
2004	Muskellunge	1,288	10.9
2007	Muskellunge	1,290	12.2
2009	Muskellunge	2,498	10.0
2011	Muskellunge	1,290	9.7
2013	Muskellunge	1,185	11.5
2015	Muskellunge	1,351	12.2
2017	Muskellunge	432	11.3